

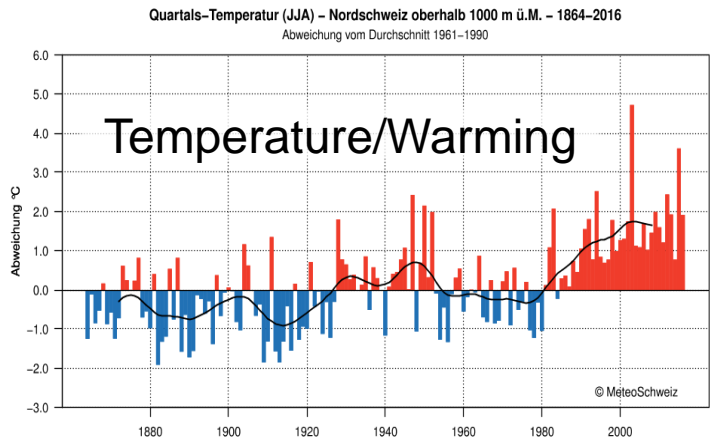
## Vegetation records at automatic climate stations II



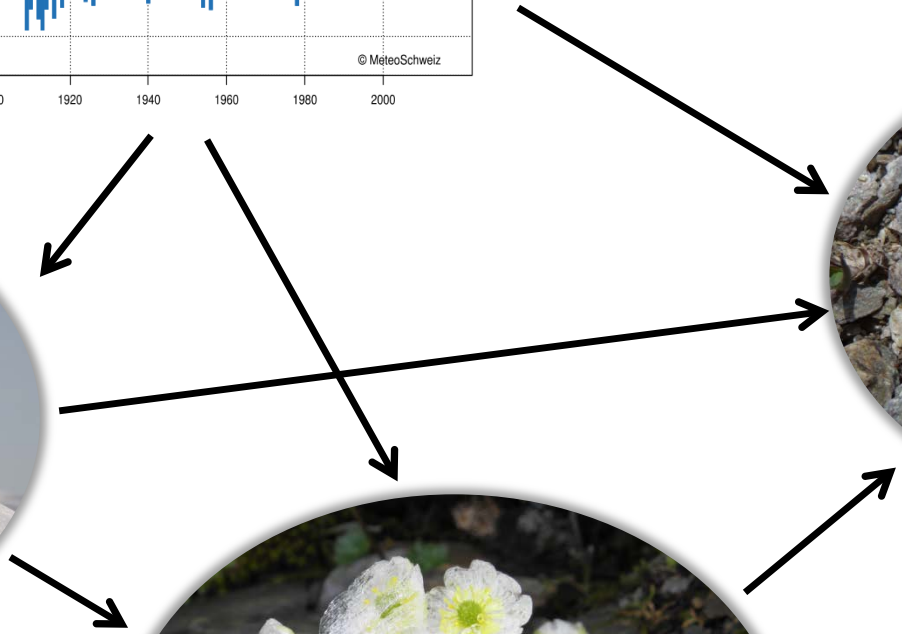




One MODIS pixel



Species composition  
Thermophilisation  
Traits  
Diversity  
etc





# The snow and meteo station

1. Ultrasonic sensor for snow depth
2. Precipitation
3. Wind speed and direction
4. Air temperature
5. Surface temperature of the snowpack
6. Reflected shortwave radiation
7. Temperature within the snow pack / soil temperature
8. solar panel
9. Antenna for radio transmission



# The snow and meteo station network

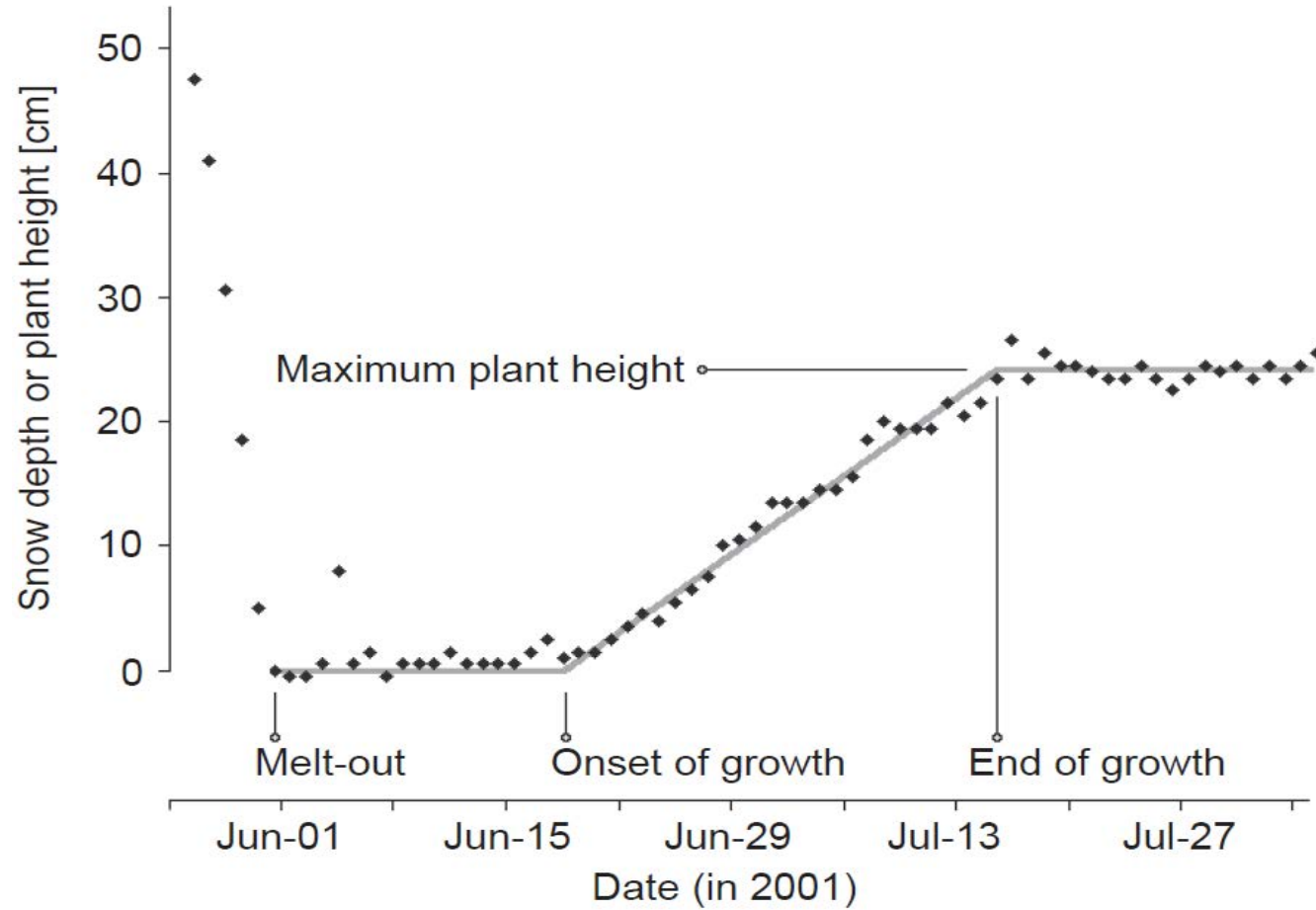
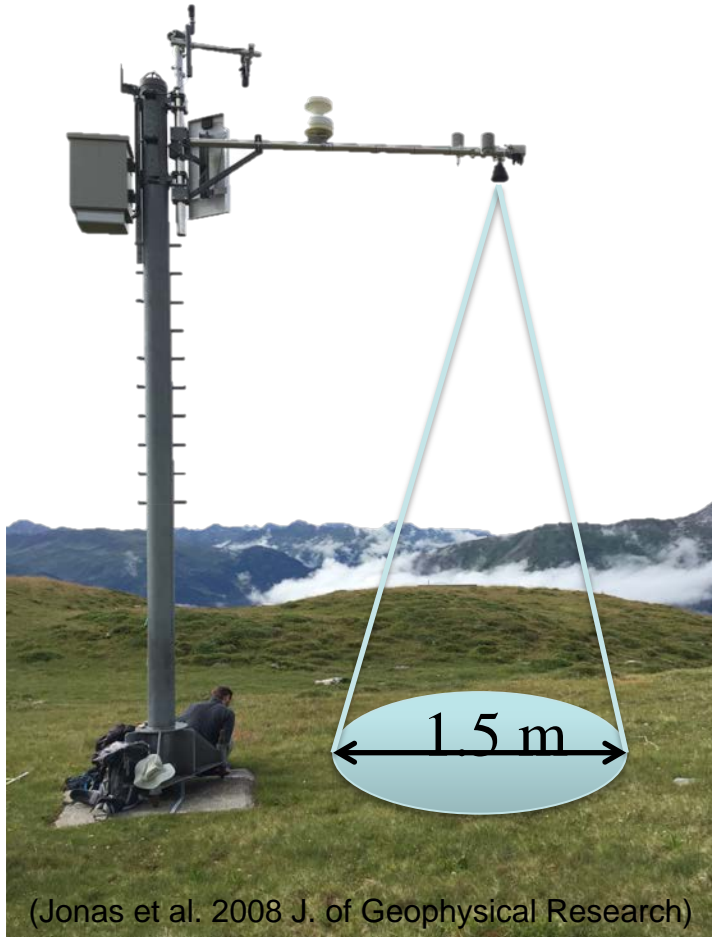


130 stations in the Swiss Alps [(1970)1994–2015, 1560 – 2900 m asl]  
plus 11 stations running for 45 years





# Hearing the grass grow

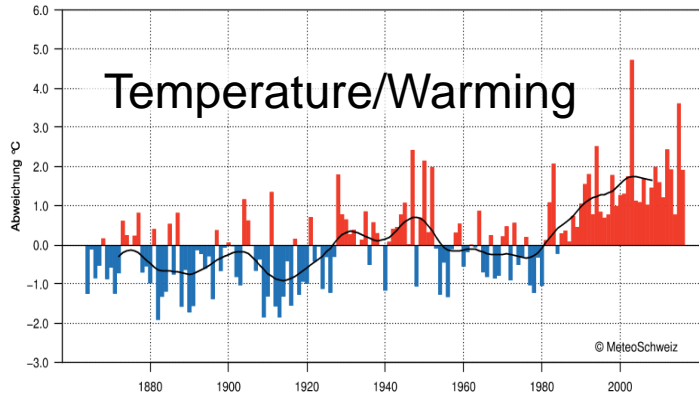


# Vegetation survey under the sensor



Species composition  
Traits  
Soil

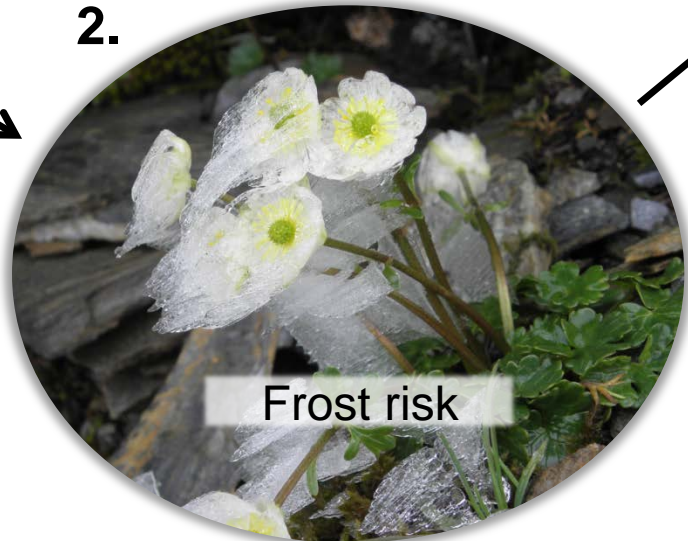
Quartals-Temperatur (JJA) – Nordschweiz oberhalb 1000 m ü.M. – 1864–2016  
Abweichung vom Durchschnitt 1961–1990



1.

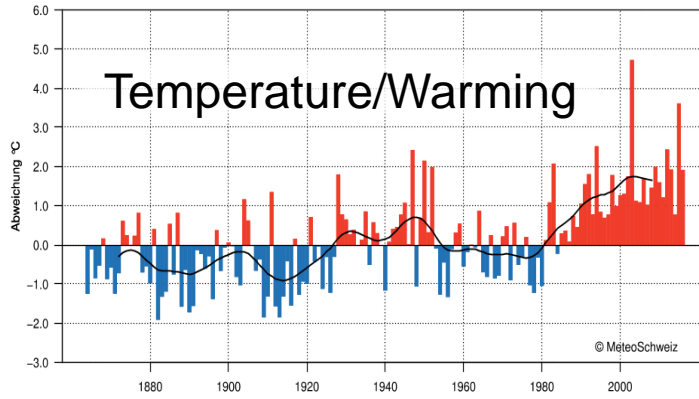
2.

3.

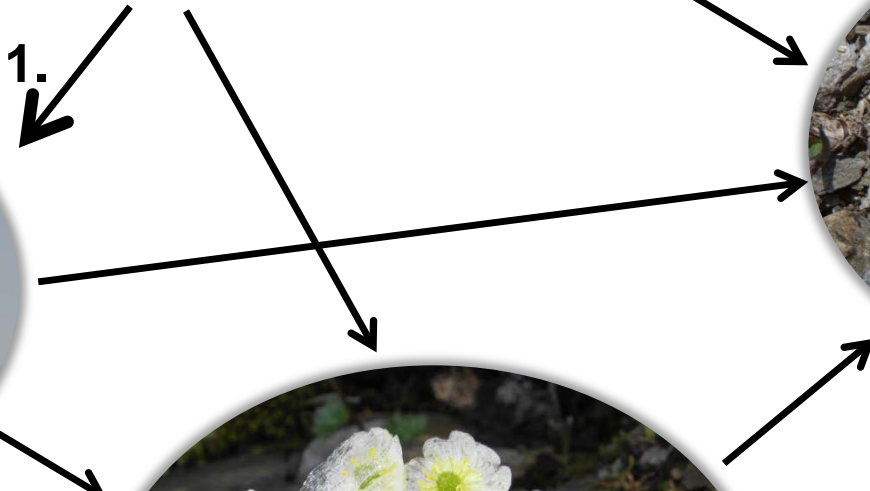


Species composition  
Thermophilisation  
Traits  
Diversity  
etc

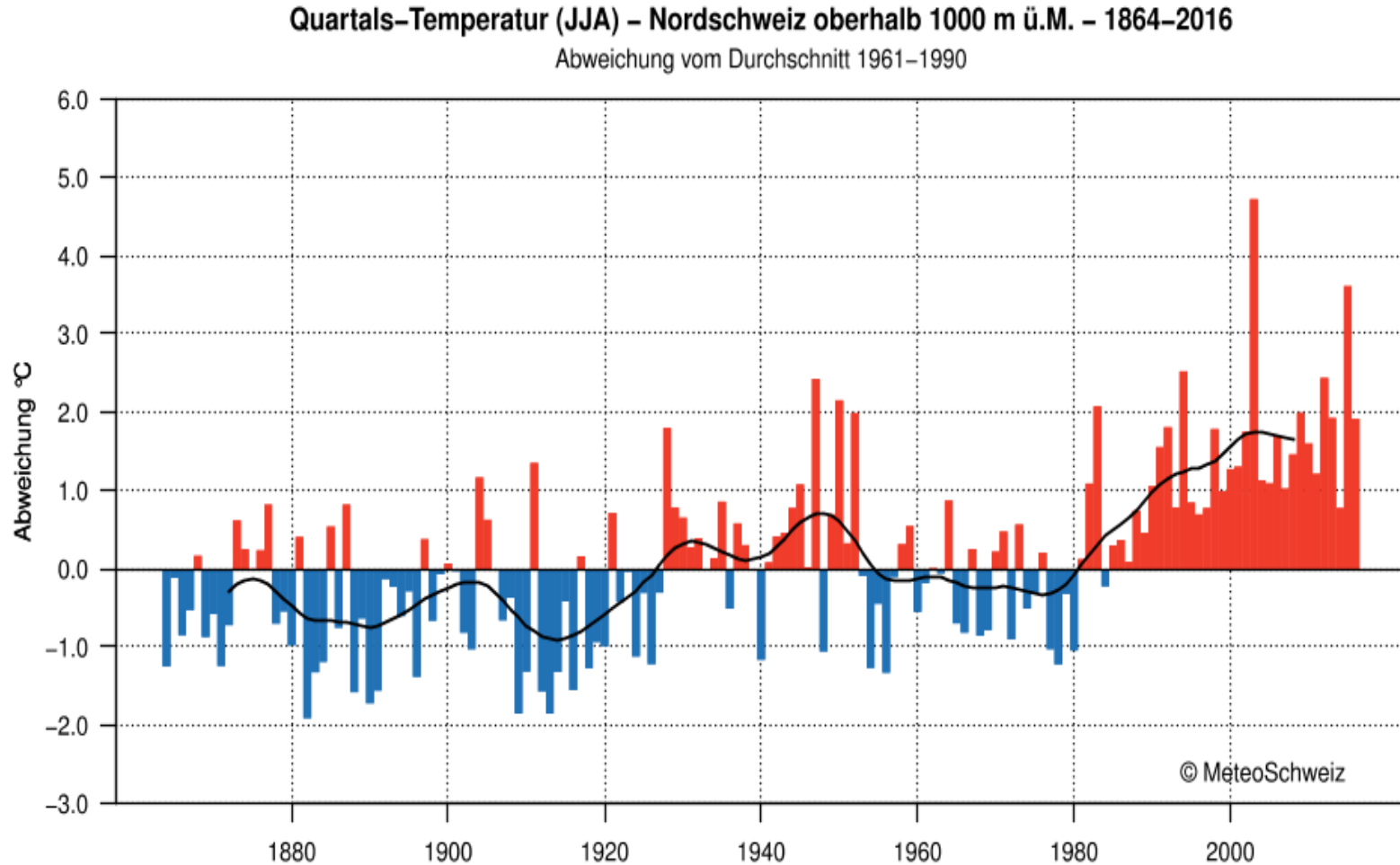
Quartals-Temperatur (JJA) – Nordschweiz oberhalb 1000 m ü.M. – 1864–2016  
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Species composition  
Thermophilisation  
Traits  
Diversity  
etc

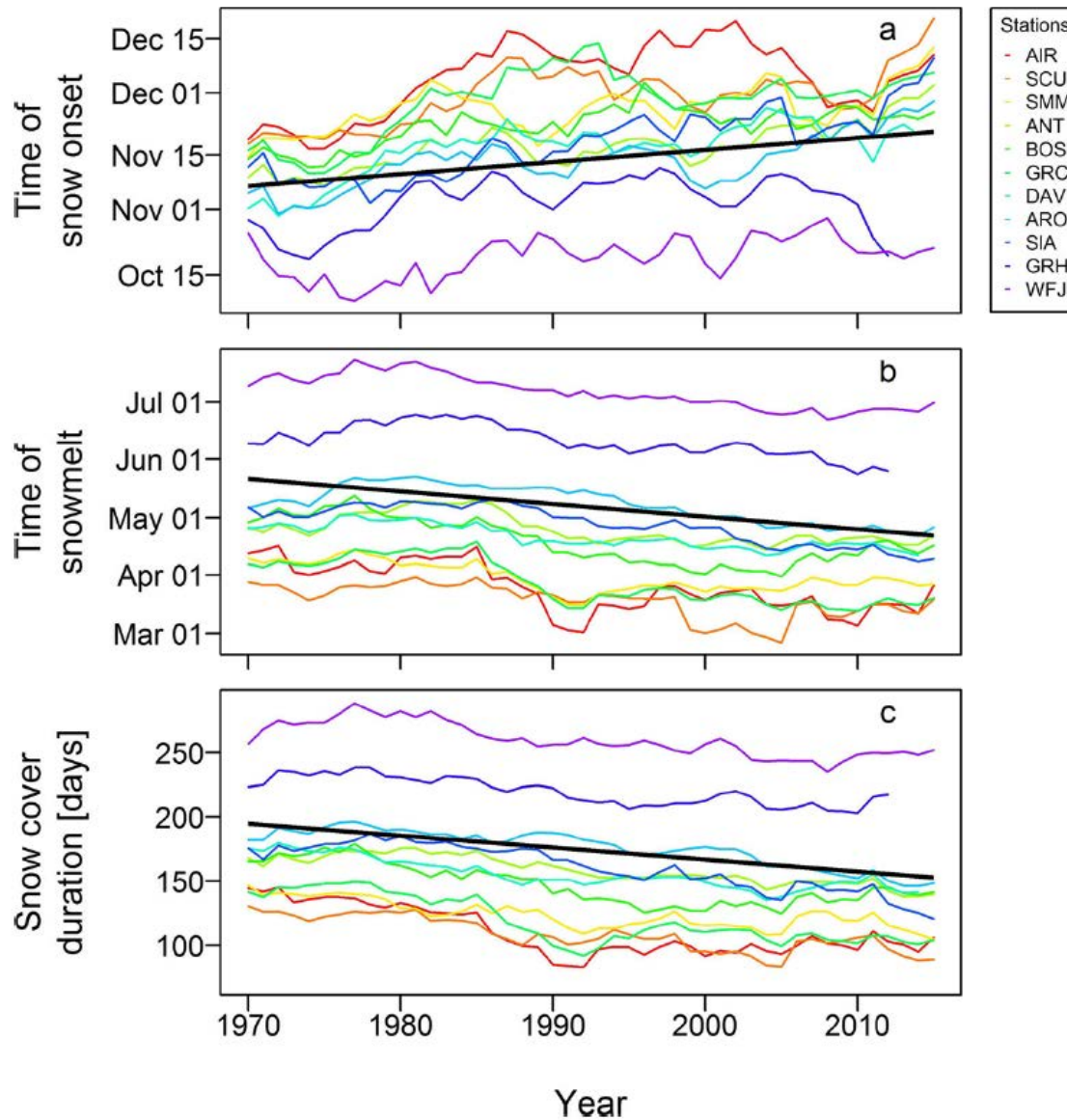


# Changes in snow?

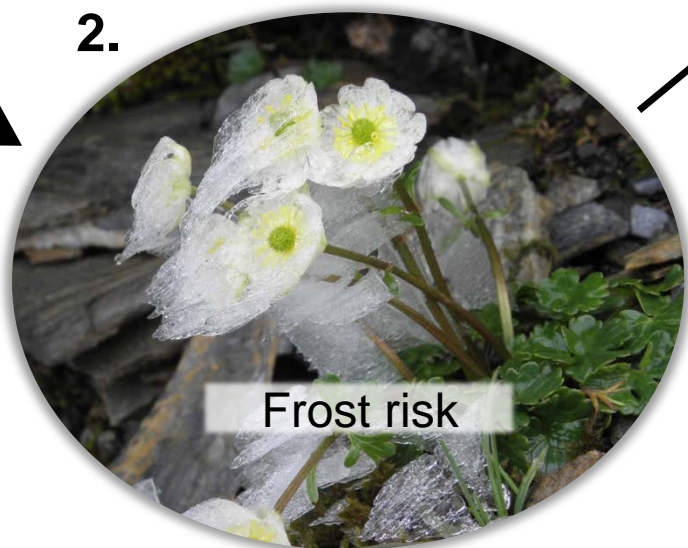
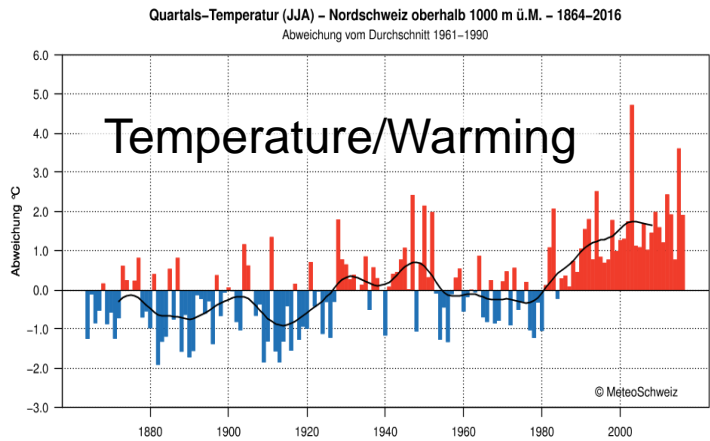


- Temperatures have warmed considerably over last decades.  
Has snow cover changed accordingly over the last **45 years** in Switzerland?  
**Less at high elevation** because precipitation is more important for snow?

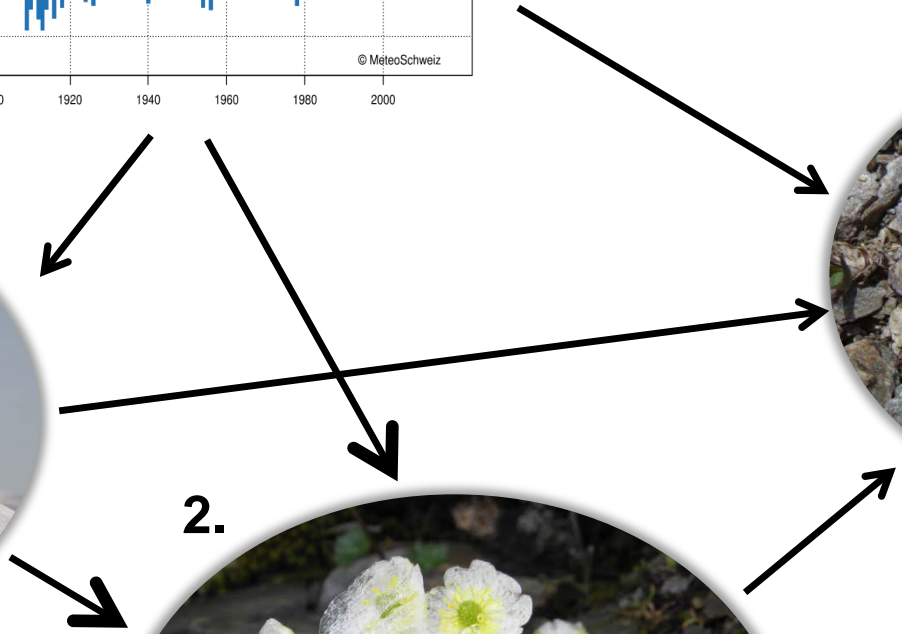
# Shorter snow cover duration since 1970 in the Swiss Alps due to earlier snowmelt more than to later snow onset



(Klein et al. 2016)



Species composition  
Thermophilisation  
Traits  
Diversity  
etc



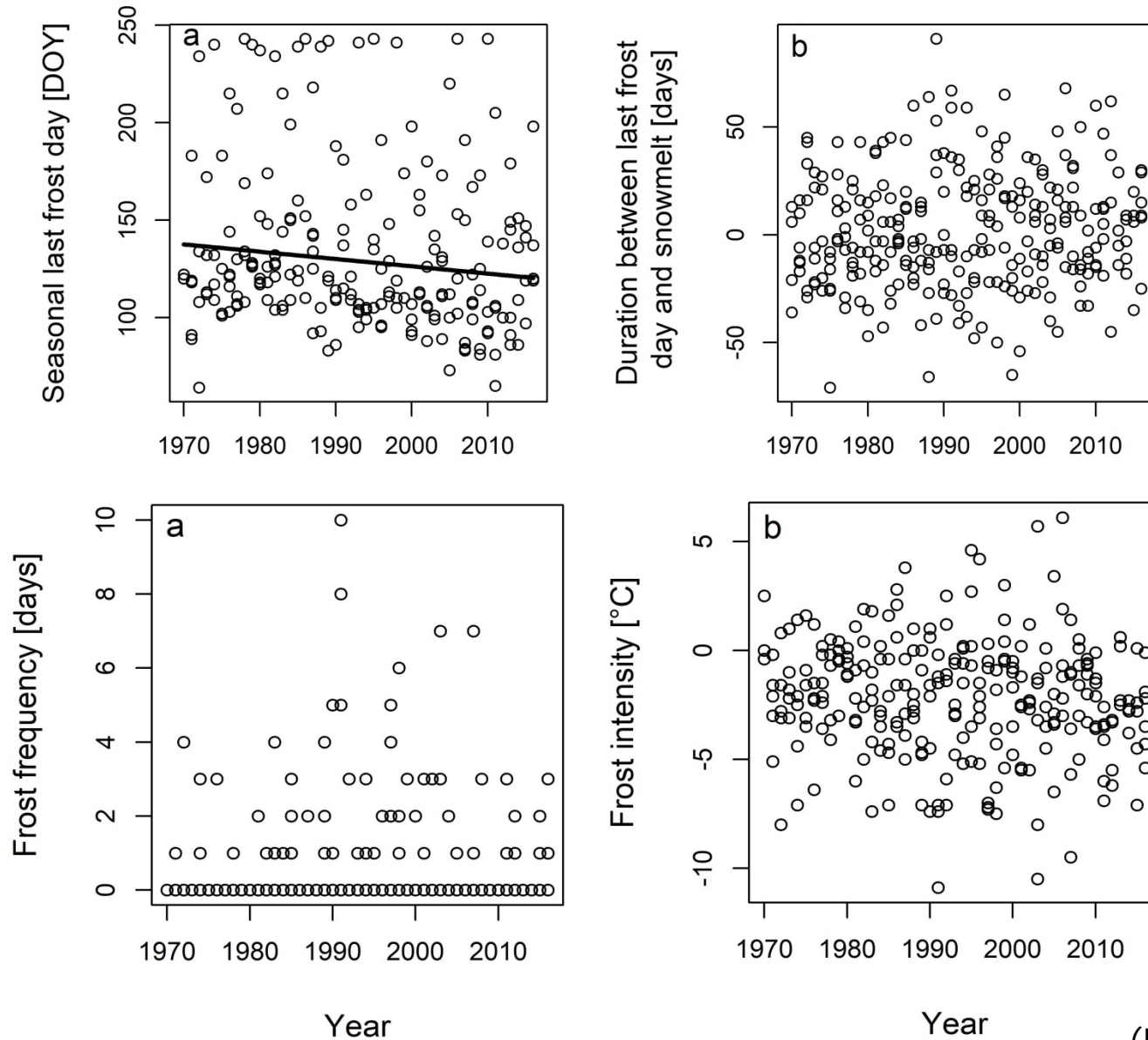
# Changes in frost risk?



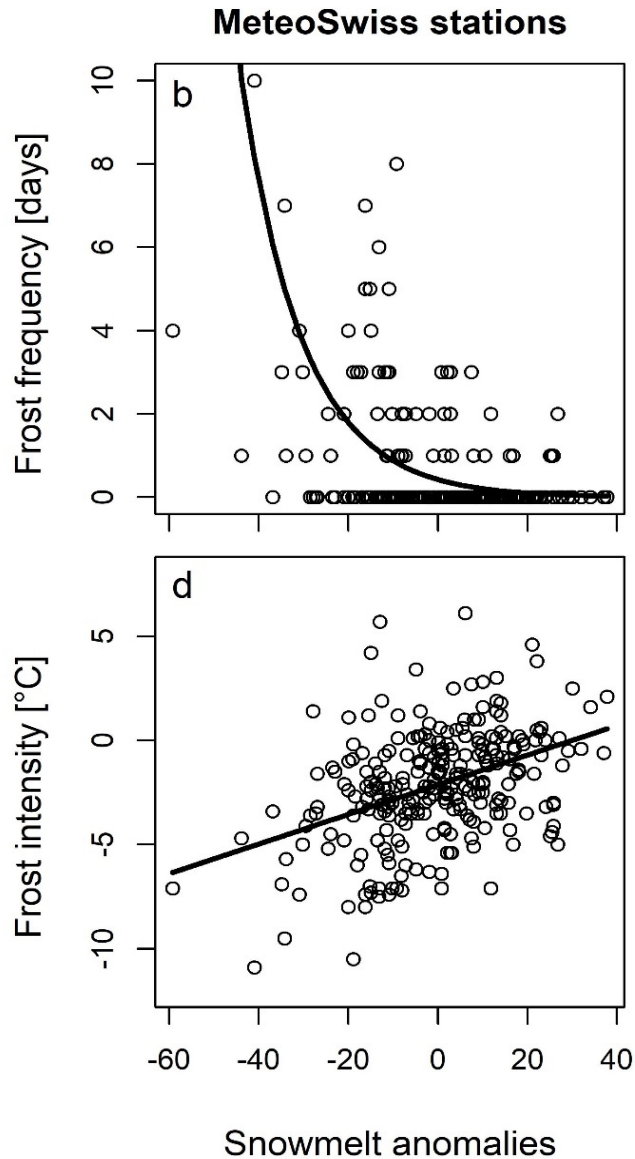
- With earlier snowmelt, frost risk could increase, decrease or remain similar
  - Changed risk of frost exposure for alpine plants after snowmelt?



# Unchanged risk of frost exposure for alpine plants after snowmelt in Switzerland despite climate warming



# Unchanged risk of frost exposure for alpine plants after snowmelt in Switzerland despite climate warming



Agricultural and Forest Meteorology 248 (2018) 60–69



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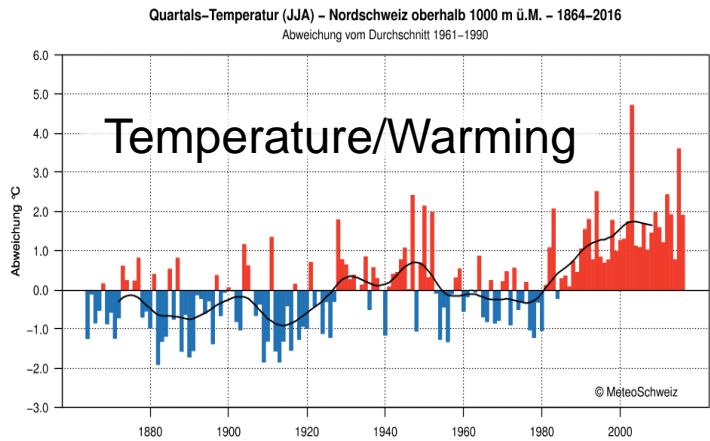


Research paper

Increase in the risk of exposure of forest and fruit trees to spring frosts at higher elevations in Switzerland over the last four decades

Yann Vitasse<sup>a,b,\*</sup>, Léonard Schneider<sup>a,b</sup>, Christian Rixen<sup>c</sup>, Danilo Christen<sup>d</sup>, Martine Rebetez<sup>a,b</sup>

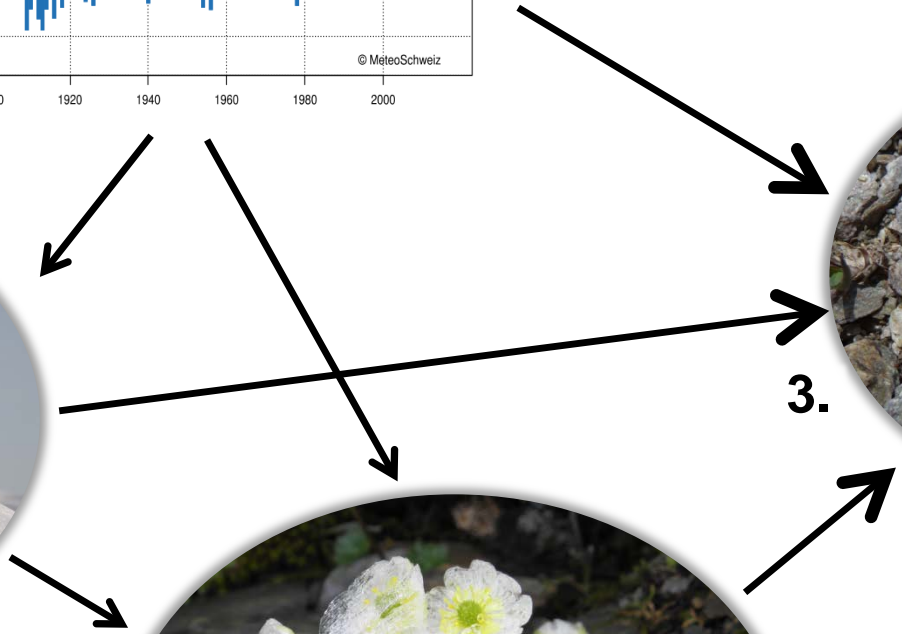




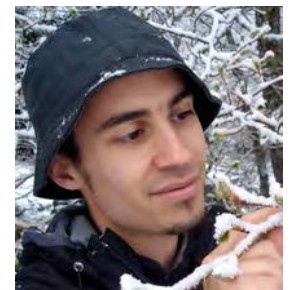
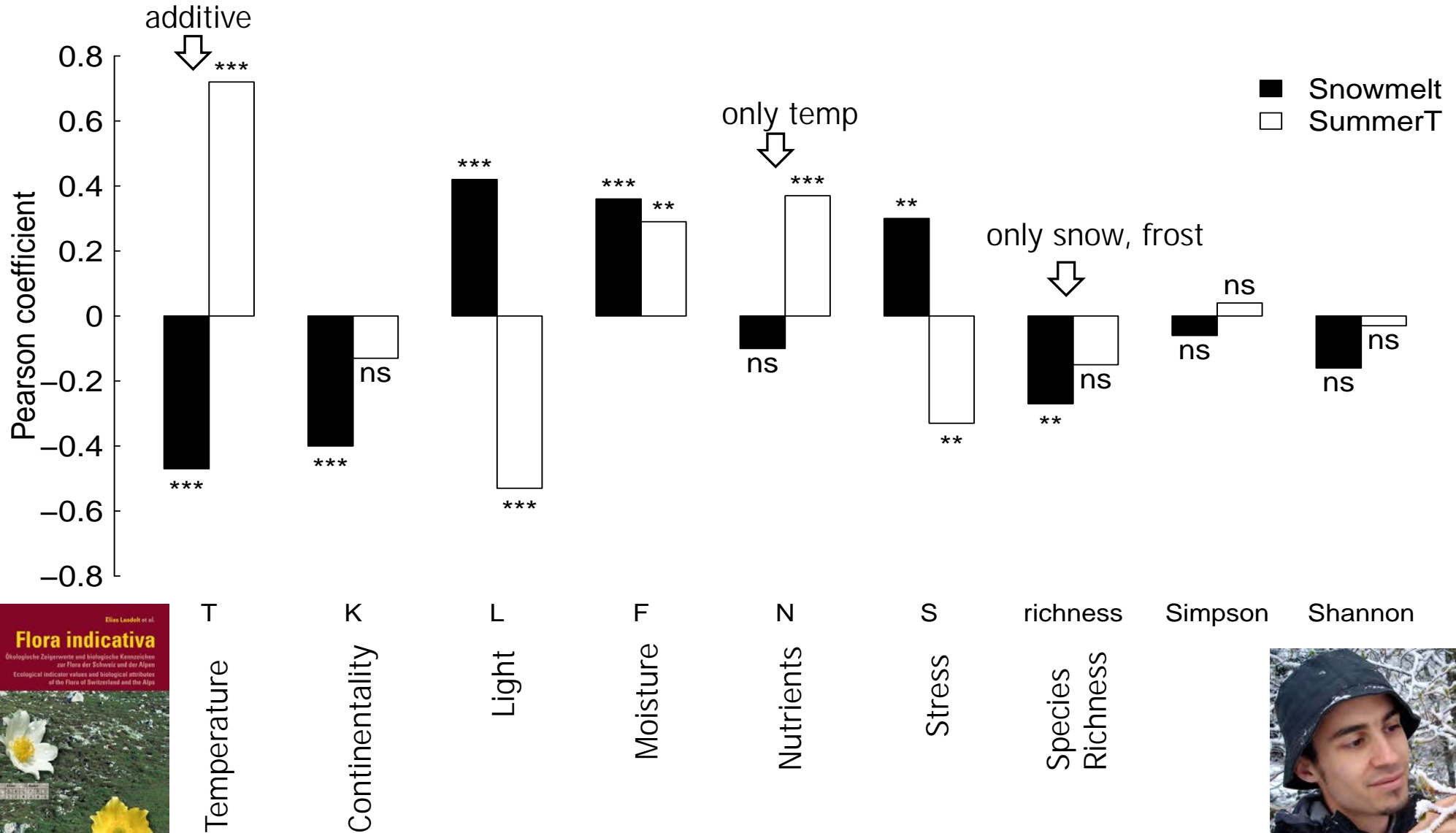
Effects of temperatures and snowmelt on species composition, plant traits, diversity?



Species composition  
Thermophilisation  
Traits  
Diversity  
etc




# Snow seasonality and summer temperature have an additive effect in shaping several aspects of alpine plant communities



(Vitasse et al. submitted)



# Next steps: you can put your dot on the map

- 
- Arctic vs. alpine, long days vs. short days
  - Continental vs. oceanic, i.e. cold and dry vs. mild and wet
  - Sites with climate change vs. sites with no (or little) change
  - Soils: microbial diversity and carbon stocks across cold biomes



Enontekio Nakkala, Finland